A Model based Approach for Multimodal Biometric Recognition

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ABSTRACT*:*
This paper presents a novel method for recognisation of user identity based on multiple traits. In this approach the concepts of fusion together with Generalized Gamma Distribution (GGD) are utilized. The performance of the model is evaluated using synthetic data and evaluation is carried out by considering metrics like False Acceptance Rate (FAR), and False Rejection Rate (FRR).

Keywords
Multimodal biometric, Fusion, Generalized Gamma Distribution (GGD), FAR, FRR

1. INTRODUCTION
Today most of the critical information is computerized and being used in public domains like banks, ATMs, Airports and other security areas .Traditional methods are used for securing these information which includes[1] usage of passwords, PIN Number, Signature etc. However, these methods are not standardized and are prone to tamper easily [2]. In order to overcome these disadvantages, good amount of research has been using biometric systems. In the biometric algorithms, the individuals are being identified by using a two tier process, viz., the psychological and behavioral pattern. Uni-model biometrics systems have been associated in most of the security concerned areas in the past few decades. But there exists several drawbacks, which include high False Acceptance Rate (FAR) and False Rejection Rate (FRR), partial bias capability, and lack of durability These systems are prone to security attacks like spoofing, Submission attacks, Imposed attack and Reply attack [4][5] additionally, they suffer with problems like non universality[6],noisy data, Intra-class variation[12]and unacceptable rate[13].To overcome these disadvantages, in this paper a multimodal biometric system is presented. Some works on multi-modal biometric recognition is presented in the literature. Dieckmann et al [4], presented a model in which integration of face, lip motion and voice were integrated, Brunelli and Falvin [5], proposed a scheme for multi modal by considering a fusion level scheme, Kittler [6], proposed a methodology by combing snapshot, where he combined the snapshots of the multimodal, Maes[7], proposed a model by integrating biometric data(face) with non-biometric data (Password) . A good selection of biometric should possess certain characteristics like uniqueness, universality, permanence, collectability, performance and acceptability, and among the various multimodal biometric combination of face, finger print, vein and speech traits are considered to be having high performance accuracy [11]. Hence, in this article, the combination of the finger-print, speech, and face templates are considered for the authentication purpose. The concept of score level fusion is applied for the verification of the user. The feature extraction is done by using GGD and MFCC. These feature vectors are processed using the GGD (Generalized Gamma Distribution) to obtain unique identification. The performance of the developed model is evaluated by using metrics like FAR (False Acceptance Rate) and FRR (False Rejection Rate). The accuracy of the model is also compared with other models of multiple biometric systems based on GMM (Generalized Mixture Model).The rest of the paper is organized is as follows.Section-2, of the paper deals with Generalized Gamma Distribution. In Section -3, extraction of biometric traits and feature vectors are discussed.Section-4 of the paper deals with score level fusion. In the section-5, experimentation together with the result is presented. Evaluation Metrics are discussed in section -6 and the final section -7 concludes the paper.

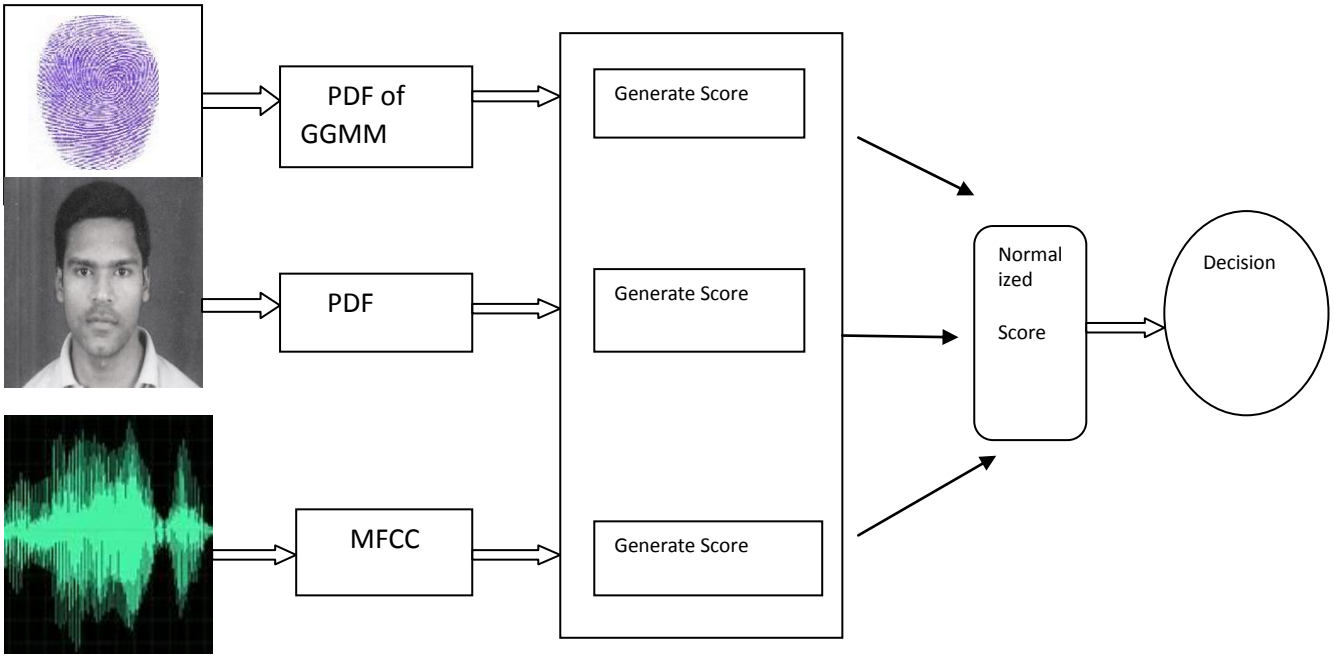

Figure-1: General Architecture of Multimodal Systems

2. GENERALIZED GAMMA DISTRIBUTION (GGD)

In this paper generalized gamma distribution is used for classification of the data to authenticate or not authenticated user. The main consideration of GGD for our approach is that biometric traits considered will be asymmetric in nature and each trait exhibits a particular pattern. In order to investigate the multiple patterns, it is needed to consider a model which handles the data having frequency distribution in uneven pattern. In particular the speech signals are asymmetric in nature and other two biometric traits considered exhibits either symmetric or asymmetric pattern. Hence to handle such sort of multiple data one way to consider GGD (generalized gamma distribution) .It also includes several other distributions like Weibull, Laplace, Raleigh, Lognormal, Gamma etc, its particular case is GMM which is symmetric and hence it can handle data both in symmetric and asymmetric features.

The PDF (Probability Density Function) of Generalized Gamma Distribution (GGD) is given

$$f(x,k,c,a,b) = \frac{c(x-a)^{ck-1} e^{-\left(\frac{x-a}{b}\right)^{c}}}{b^{ck}\Gamma(k)} \quad \text{---- (1)}$$

Where a, b, c, k are Gamma variant. c and k are shape parameter such that c, k>0.a is called as location parameter and b is called as shape parameter so that a, b>0.

3. EXTRACTION OF BIOMETRIC TRAITS

In this article we have considered the biometric traits of face, fingerprint and speech signals as input for the authenticate process. For the verification purpose, each of these traits is matched against the traits in the database. The finger print extracted is given as input to GGD(Generalized Gamma Distribution) , presented in section 2 of the paper, for the extraction of the features from the speech signals, MFCC values are considered for extraction of amplitude sequences and pixels of the facial data are given as input to the GGD to extract the PDF. These features are fused using a score level fusion.

4. SCORE LEVEL FUSION

In order to map the features from the multiple traits, score level fusion is used. It uses a Logical AND/ OR operation the match is indicated as 'Y', and Mismatch by 'N'. The verification Process is based on the value returned.

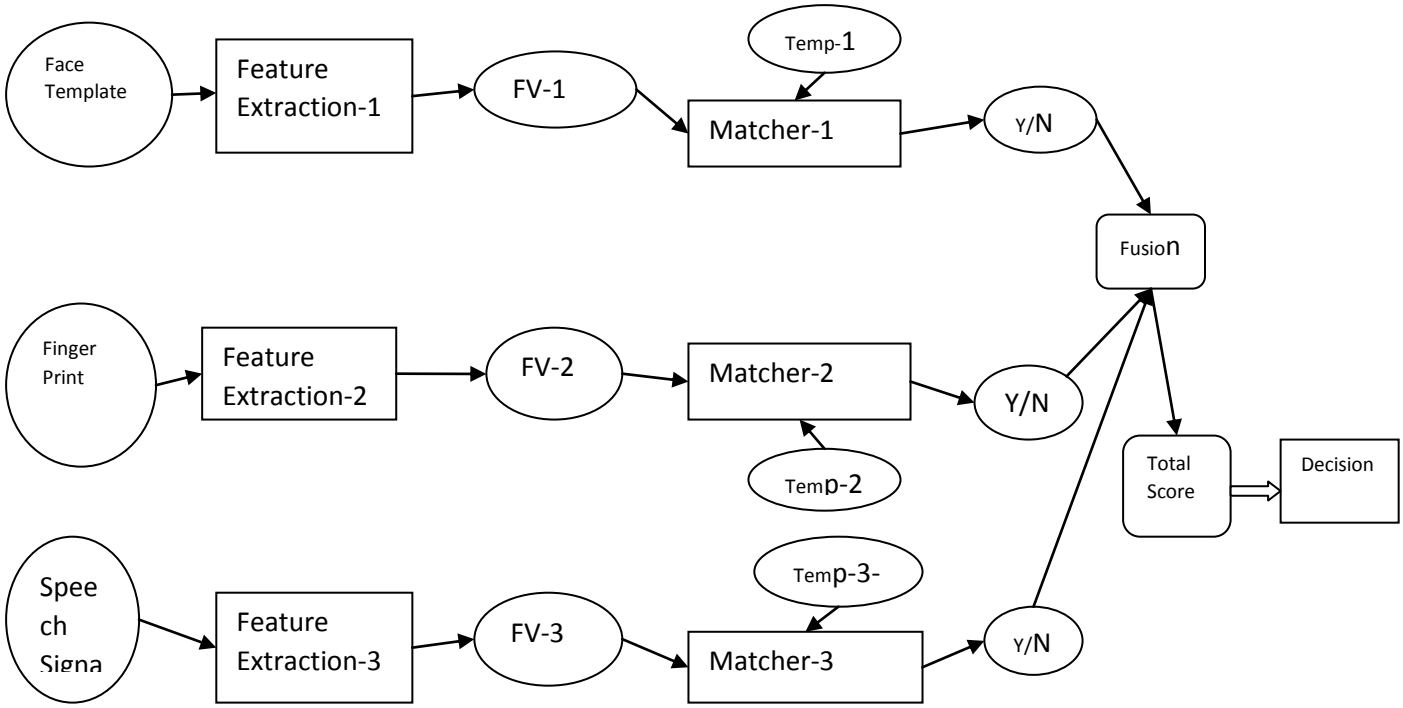

Figure-2: Fusion at Match Score Level

4.1. Normalization

Normalization is a process which is used to breed uniform values from the input scores by overcoming the incompatibilities. Let a raw matching score be denoted by's', let S denote the set of all scores of a matcher, then the Normalized Score, given by '$s^{1,}$ is given by

as s, from the set S of all scores for that matcher, and the corresponding normalized score as s'.

Z-Score: $s^1 = (s - \mu) / (\sigma)$ --- (2)

Where μ - is the Arithmetic Mean and σ denotes the Standard Deviation of the given data

5. EXPERIMENTATION

In order to evaluate the model various inputs are considered both from gender dependent and gender independent data. The database consist of 100 fingerprint, 100 facial images and also consist of speech signals of the above 100 subjects. The preprocessing is done on each of the sample and feature vectors are extracted using the concept mentioned in section-3 of the paper. The core features are extracted from each of these biometric inputs and are stored in the database. . In order to extract the speech signal, each of the subject's speech data is recorded in .WAV format and are given as input to the MFCC for extracting the amplitude signal. MATLAB voice box is considered for the extraction of these amplitude signals. For the extraction of facial features, each face is normalized into a unit square. Preprocessing is subjected to overcome lightening effects and to overcome the orientation effect frontal face are only considered. These preprocessed faces are given as input to GGD and the PDF is obtained by using the formula given in section-2. Using the MATLAB Environment. These features are fused using score level fusion, as discussed in section-4 of this paper.

*MDR=(Total no ofmissedrecognition/Total Template)*100*

*FAR= ((Total considered-Total Accepted)/Total Template)*100*

Acceptance Rate =

*(Total no of Accepted Traits/Total Traits)*100*

6. PERFORMANCE EVALUATION METRICS

Multi modal biometric systems consider more than one physiological or behavioral attribute for enrollment and verification. In order to evaluate the current methodology we have considered metric like FAR (False Acceptance Rate), FRR (False Rejection Rate).The formula for computing are given below.

False Accept Rate (FAR) : The probability that the system wrongly declares a successful match between the input pattern and a non matching pattern in the database. It measures the percent of invalid matches.

False Reject Rate (FRR): The probability that the system wrongly declares failure of match between the input pattern and the Matching Template in the database.

Table Showing the Performance of Developed Model

Biometric Traits	***Technique Adopted***	***Performance of Classification in Percentage***			***No. of subjects***
		FAR	***FRR***	***ACC RATE***	
FACE+ Speech+ Finger Print	GMM	2.85	5.84	88	100
	Proposed Model	2.02	6.14	92	100

7. RESULTS AND CONCLUSION

In this paper the concept of multimodal biometric verification is considered for authentication of an individual. This paper presents a novel methodology for establishing the identity of individual by using the concept of GGMM (Generalized Gamma Mixture Model) together with score level fusion .The Normalized data is considered for verification of an individual against template. The performance is evaluated using FAR/FRR and also compared with the existing methodology of GMM (Gaussian Mixture Model) and is presented in the table. The developed method shows good accuracy.

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